

# Effect of pelvic floor muscle exercises on pulmonary function

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**Abstract.** [Purpose] This study aimed to determine the correlation between pelvic floor muscle strength and pulmonary function. In particular, we examined whether pelvic floor muscle exercises can improve pulmonary function. [Subjects] Thirty female college students aged 19–21 with no history of nervous or musculoskeletal system injury were randomly divided into experimental and control groups. [Methods] For the pulmonary function test, spirometry items included forced vital capacity and maximal voluntary ventilation. Pelvic floor muscle exercises consisted of Kegel exercises performed three times daily for 4 weeks. [Results] Kegel exercises performed in the experimental group significantly improved forced vital capacity, forced expiratory volume in 1 second, PER, FEF 25–75%, IC, and maximum voluntary ventilation compared to no improvement in the control group. [Conclusion] Kegel exercises significantly improved pulmonary function. When abdominal pressure increased, pelvic floor muscles performed contraction at the same time. Therefore, we recommend that the use of pelvic floor muscle exercises be considered for improving pulmonary function.

**Key words:** Kegel exercise, Forced vital capacity, Maximal voluntary ventilation

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## INTRODUCTION

The pelvic floor muscles (PFM) primarily protect the endopelvic organs but are also involved in breathing during speaking, deep breathing, and coughing<sup>1)</sup>. Speaking, deep breathing, and coughing occur as the diaphragm rises due to increased abdominal pressure. Here the abdominal and PFM generate pressure through their co-contraction<sup>2)</sup>. PFM contraction protects the endopelvic organs against increased abdominal pressure under the body's certain reactions such as deep breathing and coughing and helps breathing by relieving anal and urethral obstructions<sup>3)</sup>. Therefore, PFM exercises should be included in efforts to improve pulmonary function. Although the PFM have breathing-related functions, most related studies have investigated urological diseases<sup>4, 5)</sup>. However, a few studies have examined the effects of PFM reinforcement on pulmonary function. Most studies have reported that Kegel exercises reinforce the PFM<sup>6)</sup>. Meanwhile, a recent study by Park<sup>7)</sup> attempted to identify the effects of one-time Kegel exercises on pulmonary function and reported that the vital capacity was improved in certain categories. However, one-time Kegel exercises may not be sufficient for reinforcing the PFM. Therefore, the purpose of this study was to examine the effects of self-disciplined

Kegel exercises performed for 4 weeks on PFM strength and determine whether PFM reinforcement could improve pulmonary function.

## SUBJECTS AND METHODS

The subjects of this study were 30 female students at S University in Busan City who fully understood the study's purpose and methods and agreed to participate in it. This study complied with the ethical standards of the Declaration of Helsinki, and written informed consent was obtained from each participant. Selection criteria were: no past history of nervous, musculoskeletal, or heart-lung system disease (any of which could affect our experiment); no history of participating in pulmonary function promotion exercise programs; and agreeing not to perform any other exercises during the experiment. The subjects were randomly divided into a Kegel exercise group and a control group that received no treatment ( $n = 15$  each). Two individuals in both the test and control groups did not participate in the second round of measurements; therefore, their measured values were excluded from the collected data. The control group had an age of  $20.23 \pm 0.78$  years, height of  $159.13 \pm 3.62$  cm, and weight of  $55.20 \pm 6.67$  kg, while the experimental group had an age of  $20.41 \pm 0.84$  years, height of  $158.30 \pm 4.70$  cm, and weight of  $54.14 \pm 5.88$  kg. A digital Pony FX microspirometer (Cosmed Inc, Italy) was used to measure pulmonary function by determining the amount and velocity of air that enters and exits the lung. This study measured forced vital capacity (FVC) and maximal voluntary ventilation (MVV).

The FVC measurement was made while the subjects were

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sitting on a chair with their limbs and shoulders straight and legs spread shoulder-width apart and perpendicular to the ground. They were then instructed to close their nose using a nose clamp and hold the measuring instrument with one hand and let it nip the mouth. Measurements were taken while the subjects breathed normally three or four times and then took a deep and fast inspiration followed by a fast expiration. The expiratory breath was maintained for 6 seconds. The MVV was then measured with the subjects in the same position. The subjects were led to perform inspiration and expiration for 12 seconds in the deepest and fastest manner. Each measurement was taken three times, and the average value of each was used in the analysis. The first round of measurements was taken before the start of the Kegel exercises, while the second round of measurements was taken after the end of the 4-week Kegel exercises course. Kegel exercises have been shown to help reinforce the PFM<sup>8)</sup>. The ready position of Kegel exercises was lying on the floor with the knees bent and the soles touching (frog position). Next, without contracting the abdominal, lumbar, gluteal, and lower-limb muscles, the subjects slowly contracted only the PFM for 5 seconds; at the fifth second, they performed a maximum contraction of the muscle. The subjects relaxed at the sixth second and performed a fast contraction and relaxation between the seventh and ninth seconds, then rested at the tenth second. One set of exercises included performing ten sets of the above exercise twice. A 40-second break was provided between sets.

The statistical program SSPWIN (ver 21.0) was used for the analysis, and the statistical significance level was set at  $\alpha = 0.05$ . This study used paired t-tests to compare the test and control groups before and after the exercises, and an analysis of covariance test was conducted to identify differences in variations between the two groups.

## RESULTS

The changes in pulmonary functions of the test group before and after Kegel exercises were as follows. Among the

lower-level categories of FVC, the FVC increased from 2.75 L to 3.13 L ( $p < 0.05$ ), FEV<sub>1</sub> increased from 2.39 L to 2.78 L ( $p < 0.05$ ), PEF increased from 4.48 L to 5.97 L ( $p < 0.05$ ), FEF 25–75% increased from 2.83 L to 3.48 L ( $p < 0.05$ ), and FVC increased from 1.53 L to 1.81 L ( $p < 0.05$ ). These increases were all statistically significant. On the other hand, while the FEV<sub>1</sub>/FVC increased from 87.15% to 89.19%, this result was not statistically significant. The MVV increased from 84.88 L to 112.62 L, a difference that was statistically significant ( $p < 0.05$ ) (Table 1).

Changes in pulmonary functions of the control group were also examined between the first and second measurements rounds. The FVC decreased from 3.06 in the first round of measurements to 2.98 in the second round of measurements, FEV<sub>1</sub> declined from 2.48 to 2.33, FEV<sub>1</sub>/FVC decreased from 82.50 to 75.81, PEF decreased from 4.66 to 4.46, FEF decreased from 2.57 to 2.50, and FIC decreased from 1.65 to 1.64. However, these changes were not statistically significant. While the MVV increased from 85.56 to 90.80, this result was also not statistically significant ( $p > 0.05$ ) (Table 1).

Comparison of changes in pulmonary functions of the test and control groups showed the following. The test group showed increases in FVC ( $p < 0.05$ ), FEV<sub>1</sub> ( $p < 0.05$ ), and PEF ( $p < 0.05$ ), whereas the control group exhibited decreases in the same variables. These results were statistically significant. For FEV<sub>1</sub>/FVC, the test group showed an increase and the control group exhibited a decrease, but these changes were not statistically significant. In addition, both the test and control groups revealed increased FEF 25–75% and FIC without statistical significance. For MVV, the test group showed an increase and the control group exhibited a decrease. These differences were statistically significant ( $p < 0.05$ ) (Table 1).

## DISCUSSION

In normal breathing, inspiration refers to the entry of external air into the body as the diaphragm contracts and moves

**Table 1.** Pulmonary function changes by group

	Group	Pre-exercise	Post-exercise
FVC (L)*	Experimental	2.75±0.47	3.13±0.47
	Control	3.06±0.31	2.98±0.36
FEV <sub>1</sub> (L)*	Experimental	2.39±0.51	2.78±0.38
	Control	2.48±0.25	2.33±0.49
PEF (L/s)*	Experimental	4.48±1.42	5.97±1.49
	Control	4.66±0.77	4.46±1.34
FVC	FEV <sub>1</sub> /FVC (%)	87.15±7.93	89.19±6.64
	Control	81.32±7.05	78.44±14.55
FEF 25–75% (L/s)	Experimental	2.83±0.98	3.48±0.77
	Control	2.50±0.56	2.94±0.87
IC (L)	Experimental	1.53±0.37	1.81±0.30
	Control	1.75±0.21	1.77±0.28
MVV	MVV* (L/min)	84.88±13.23	112.62±19.92
	Control	92.41±8.80	91.48±7.74

Mean ± SD, \* $p < 0.05$

downwards, while expiration refers to the relaxation and upward movement of the contracted diaphragm. However, when forced expiration or coughing occurs, the anterior and lateral abdominal muscles contract, thereby generating pressure that strongly moves the diaphragm upward. Here PFM contraction helps maintain the abdominal pressure. From this viewpoint, the PFM and deep abdominal muscles are involved in breathing through their concerted contractions<sup>9)</sup>.

This study used Kegel exercises to reinforce the PFM<sup>8)</sup>. The reinforcement of the PFM through Kegel exercises improved the lower-level FVC categories. This result verifies that PFM reinforcement through Kegel exercises has positive effects on improving the FVC, which requires increases in intra-abdominal pressure. This finding coincides with those of a study by Sapsford<sup>10)</sup>, which showed that PFM contraction generated forced expiration when conditions requiring increases in abdominal internal pressure occurred, such as nose blowing, coughing, and sneezing. In addition, the FVC measured in the present study included the process of forced expiration after maximal inspiration. Eventually, the PFM that was reinforced when intra-abdominal pressure increased during the process of forced expiration may have also performed co-contraction, thereby reinforcing forced expiration, which subsequently increased the FVC. The MVV, another variable tested in this study, also increased. The MVV is measured after breathing for 12 seconds in the deepest and fastest manner; thus, it increases intra-abdominal pressure. Since increased intra-abdominal pressure activates the PFM, the MVV may have increased after Kegel exercises.

This study has a certain limitation. It was conducted based on the assumption that a 4-week Kegel exercise program reinforced the PFM, but it did not directly confirm this hypothesis. In other words, this study measured the

vital capacity based on the result of preceding research that Kegel exercises performed for 4 weeks reinforced the PFM. Therefore, additional studies are required to verify that Kegel exercises directly reinforce the PFM and then identify the correlation between PFM reinforcement and pulmonary function.

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